

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
2 August 2001 (02.08.2001)

PCT

(10) International Publication Number
WO 01/56308 A2(51) International Patent Classification⁷: H04Q 7/00

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(21) International Application Number: PCT/US01/02526

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(22) International Filing Date: 26 January 2001 (26.01.2001)

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(25) Filing Language: English

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TI, TM), European

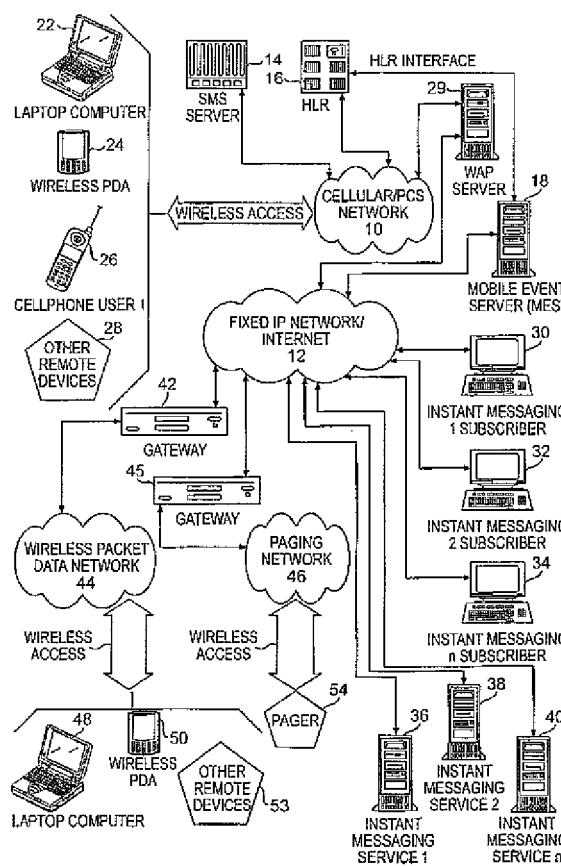
(26) Publication Language: English

(30) Priority Data:
60/178,142 26 January 2000 (26.01.2000) US(71) Applicant: INVERTIX CORPORATION [US/US];
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(54) Title: METHOD AND APPARATUS FOR SHARING MOBILE USER EVENT INFORMATION BETWEEN WIRELESS NETWORKS AND FIXED IP NETWORKS



(57) **Abstract:** The present invention provides for a system and method for sharing user event information (such as, and without limitation, presence on a network) among mobile (wireless) devices and those connected to fixed IP networks such as the Internet. In accordance with embodiments of the invention, the system and method support instant messaging between wireless devices and fixed IP network devices and between wireless devices and other wireless devices. The term wireless device is used broadly to include cell phones, laptop computers with wireless modems, wireless PDAs, and any other remote wireless devices.



patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

- *without international search report and to be republished upon receipt of that report*

**METHOD AND APPARATUS FOR SHARING MOBILE USER EVENT INFORMATION
BETWEEN WIRELESS NETWORKS AND FIXED IP NETWORKS**

INTRODUCTION

1. The present invention relates generally to instant messaging (IM) communications. More specifically, the present invention is a system and method for sharing user event information (such as, and without limitation, presence on a network) among mobile (wireless) devices and those connected to fixed IP networks such as the Internet.

BACKGROUND OF THE INVENTION

2. Instant messaging has become a mainstay of Internet communications.

3. As used in this application, instant messaging includes the ability for one user to immediately become aware of the presence of another user on the network. Thus the mere event of user A signing onto the Internet gives rise to an indication to user B that the user A is present on the network. Once user B is aware of user A's presence on the network, user B can send instant messages to user A with a high level of confidence that the messages are being received in near real-time.

4. America Online Instant Messenger™ (AIM) and ICQ® are two examples of instant messaging services that allow users on a network to identify the on-line presence of other users who have been associated in a database, commonly referred to as a buddy list. In this fashion, users can know when individuals on their buddy list are on line and hence facilitate instant communications. As of 2000, AOL's statistics on its instant messaging users indicate that these users are producing approximately 476,000,000 messages a day online. ICQ members produce nearly 350,000,000. At any one time there are 1 million people using these systems. AIM and ICQ are just two of the available messaging systems. Instant messaging is offered through virtually every web portal including Yahoo, Netscape, and MSN.

5. Two technical innovations are generally responsible for the current popularity of instant messaging on fixed IP networks. In 1996, a method was designed to fix addresses to users, allowing people to build a buddy list, similar to an e-mail address book, of friends and colleagues to communicate with via instant messaging. The second major innovation

is the free distribution of these applications. This began in 1997 when AOL made its Instant Messenger, which had been available to their paying customers for years, freely available for anyone on the Internet to download and begin using. From this simple beginning just a few years ago, instant messaging has currently become ubiquitous on fixed IP networks with IM clients existing for Windows, Mac, Linux, and Unix.

6. However, even though instant messaging is commonly used on fixed networks, it is not generally available for wireless devices. What is needed is a method and apparatus for sharing user event information, such as presence on a network, among mobile devices and those connected to fixed IP networks such as the Internet. This would allow general availability of instant messaging between personal computers on fixed networks with wireless devices on wireless networks. In this fashion communication among individuals who are both on a fixed IP network such as the Internet and those on a cellular/PCS network can be facilitated.

SUMMARY OF THE INVENTION

7. It is therefore an object of the present invention to permit instant messaging between wireless devices and fixed IP network devices.
8. It is also an object of the present invention to record events when wireless devices connect to the wireless network so that the events can be broadcast to instant messaging services of various types.
9. It is an additional object of the present invention to receive events when users log on to fixed networks so that the events can be broadcast to instant messaging services of various types for wireless devices.
10. It is yet another object of the present invention to establish interconnection between cellular/PCS networks and fixed IP networks in order to allow instant messaging to take place between wireless and fixed IP networks.
11. It is an additional object of the present invention to establish interconnection between wireless users on cellular/PCS networks in order to allow instant messaging to take place between various wireless users.
12. The present invention is a system and method for sharing mobile user event

information between wireless networks and fixed IP networks such as the Internet. The phrase "mobile user event information" will be understood to mean information regarding the presence of a wireless or mobile device on its associated network. The present invention provides the advantage of bridging the gap between the instant messaging services of fixed IP networks and wireless devices, including but not limited to wireless devices that are enabled via the Wireless Application Protocol (WAP).

13. This means that a user of an instant messaging service will be able to include in the wireless users in the buddy list. These new buddy list members include cellular or PCS wireless users whose networks are integrated with a service according to the present invention, as well as the devices of users that are on a wireless packet data network or are on a paging network. It will be understood in this description that a "wireless device" includes a wireless telephone (cellular, PCS, or configured according other wireless standards, such as GSM), a pager, a personal digital assistant, a vending machine, a vehicle, an appliance, or any other instrument or device that is connectable to an interconnected global network of networks (e.g., the Internet) via its respective wireless network.

14. As in the case of an Internet-connected user, the cellular/PCS subscriber can also establish an instant messaging list that may contain an Internet messaging subscriber, a wireless packet data device, a paging device, another cellular PCS subscriber, or indeed any other type of device and associated address that one would normally find within a fixed IP network. Thus, when a cellular user logs onto his cellular network, the various instant messaging services are notified of the cellular user so that an individual at a fixed IP network address can send instant messages or make telephone calls to the cellular user as appropriate.

15. One aspect of the present invention is a mobile event server (MES) that is connected to the home location register (HLR) platform at a wireless operator's switching facility, which is itself connected to a short messaging service (SMS) server. The MES is also connected to a fixed IP network (e.g., the Internet). This MES structure facilitates the sharing of mobile user event information, and provides mobile users with IM information about fixed IP network users. The MES may also be referred to by the trade name of IM Anywhere server.

BRIEF DESCRIPTION OF THE DRAWINGS

16. Additional objects and advantages of the present invention will be apparent in the following detailed description read in conjunction with the accompanying drawing figures.
17. Fig. 1 illustrates the overall system architecture in accordance with one embodiment of the present invention.
18. Fig. 2 illustrates the data flow when a cellular telephone user connects to the cellular network in accordance with a further embodiment of the present invention.
19. Fig. 3 illustrates the data flow when an instant messaging subscriber logs onto a network in accordance with another embodiment of the present invention.
20. Fig. 4 illustrates that data flow when a data packet system informs the MES of its presence in accordance with a further embodiment of the present invention.
21. Figs. 5a and 5b illustrate a system and method, respectively, for replication and forwarding of user event information to the MES in accordance with a further embodiment of the present invention.
22. Figs. 6a and 6b illustrate a system and method, respectively, for link monitoring and forwarding of SS7 messages in accordance with a further embodiment of the present invention.
23. Figs. 7a and 7b illustrate a system and method, respectively, for use of HLR triggers to forward presence and/or location information to the MES in accordance with a further embodiment of the present invention.
24. Figs. 8a and 8b illustrate a system and method, respectively, for use of MES polling of the HLR for user event information in a non-SS7 network in accordance with a further embodiment of the present invention.
25. Figs. 9a and 9b illustrate a system and method, respectively, for use of MES polling of the HLR for user event information in an SS7 network in accordance with a further embodiment of the present invention.
26. Figs. 10a and 10b illustrate a system and method, respectively, for use of MSC generated presence and/or location SS7 messages in accordance with a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

27. The present invention comprises a system and method for sharing mobile user event information between wireless networks and fixed IP networks thereby allowing instant messaging to occur among wireless devices and devices on a fixed IP network.
28. For example, when a cellular telephone user turns on his telephone, an event trigger is initiated and recorded in the home location register (HLR) of the associated cellular network. The HLR informs the mobile event server (MES) of the event and relays the telephone number subscriber name, network location, and other data that constitutes a subscriber record at the HLR.
29. Based on the content of the cellular telephone user's instant messaging list, the MES broadcasts a cellular telephone user's presence to various services (specifically, those services previously designated by the mobile telephone user during setup). The MES queries the various services to determine the status of the subscribers that are on the cellular telephone user's list. The MES will also inform other servers that the cell phone user is online. Based on the results of the MES query, the MES informs the cellular telephone user of various other instant messaging subscribers or devices that are online.
30. Conversely, when an IM subscriber on a fixed IP network logs onto the instant messaging service, that instant messaging service informs (based on the IM subscriber's buddy list) the MES server, as well as paging devices or other wireless devices, that the individual user is online. The MES also retrieves the status of other cell phone users to determine what users are on line.
31. If a cellular telephone user's phone is turned on, the MES server informs the SMS server which in turn sends an over the air programming (OTAP) message (or similar type message) to the cell phone user regarding the presence of the instant messaging subscriber. This message can be in the form of a message on a small screen on the user's cell phone or sending a short message to the cell phone. This is a "push" method of providing the information.
32. As an alternative, the MES informs the HLR that a user has come online, and the HLR informs the cell phone of the presence of a user. This is another form of "push" method. As another alternative, the cellular phone queries the MES over the Internet (via

the WAP server) for the status of who is online. This is a "pull" method of obtaining the information.

33. If a wireless packet network device or a paging device is turned on, the device informs the MES of its presence on the network and the MES then broadcasts (or "pushes") the presence to the appropriate services and users. As an alternative "pull" method, the status of user's devices on wireless packet networks and paging networks is queried through the MES server.

34. Referring to Fig. 1, the overall system architecture according to one embodiment of the present invention is illustrated. The present invention comprises a mobile event server (MES) 18 which interfaces with a home location register (HLR) 16. Communication between the MES 18 and the HLR platform 16 is conducted through a communication interface such as an external provisioning interface (EPI), SS7, or any other appropriate interface. The home location register is connected to a cellular/PCS network 10 over which various wireless devices such as a laptop computer 22, wireless PDA 24, cell phone 26, and other remote device 28 communicate. A short messaging service (SMS) server 14 is connected to cellular/PCS network 10 for sending messages to wireless subscribers. A wireless application protocol (WAP) server 29 is connected to cellular PCS network 10 for servicing wireless phones that are WAP enabled.

35. The mobile event server 18 is connected to a fixed IP network 12, which is preferably the Internet. Instant messaging subscribers 30, 32, and 34 are also connected to the Internet and are using a variety of possible instant messaging clients such as ICQ, Yahoo, and AOL Instant Messenger. Furthermore, instant messaging services (or servers) 36, 38, and 40 are also connected to fixed IP network 12.

36. The system shown in Fig. 1 also works with other wireless devices such as laptop computers 48, wireless PDAs 50, and other remote devices 53 that are connected via wireless access to a wireless packet data network 44. Wireless packet data network 44 is connected via a gateway 42 to fixed IP network 12. Similarly, pagers 54 are connected in a wireless mode to a paging network 46 that is also connected to a gateway 45 thereby allowing connection to fixed IP network 12.

37. Referring to Fig. 2, the data flow when a cellular telephone user connects to the

network is illustrated. A cellular user logs onto the system 60. Upon log on, an event is recorded by the HLR 62, which retrieves information 63 from storage at the HLR concerning the phone number, subscriber name, network location, and other data which constitutes the subscriber record at the HLR. The HLR informs the message event server (MES) 64 and, based upon information for the cellular telephone user's messaging list (buddy list), the MES broadcasts the presence 66 of the cellular telephone user to instant messaging services 36, 38, 40, which in turn send the appropriate notification to instant messaging subscribers 30, 32, 34 respectively, to packet data network 44, to paging network 46, and to other cellular or wireless devices 68.

38. Also based on the cellular telephone user's instant messaging list, the MES server will specifically query 70 appropriate instant messaging servers 36, 38, 40, packet data network 44 paging network 46, and other cellular/wireless devices 68 regarding whether specific individuals or devices on the cellular telephone users instant messaging list are present. Based upon the query results the MES server informs SMS server 72 of other instant messaging subscribers and wireless devices that are on line, by the SMS server updates the cellular telephone users instant messaging list 73, by sending a short message service message to the cell phone user through the SMS server. Additionally, the MES server can inform the HLR that a user on a fixed IP network has come on line. Further, alternatively, the cell phone user may query the MES server through a WAP interface.

39. Referring to Fig. 3, the data flow when an instant messaging subscriber logs onto the system is illustrated. When an instant messaging subscriber on a fixed IP network logs onto the instant messaging service 74 the instant messaging service notifies those on the subscriber's list, for example a paging network 76, a wireless network 78 and the MES server 80, that the individual user is on line. The MES then checks 82 to see if the cellular telephone user is on line. If a cellular telephone user's phone is turned on, the MES server informs the SMS server which in turn sends an over the air programming (OTAP) message (or similar type message) to the cell phone user 84 regarding the presence of the instant messaging subscriber. This message can be in the form of a message on a small screen on the user's cell phone or sending a short message to the cell phone. This is generally known as a "push" method.

40. As noted above, the MES server can also inform the HLR that a user on a fixed IP

network has come on line. And the Cellular phone can also query the MES server through a WAP server over the Internet for the status of who is online, a form of "pull" method.

41. Referring to Fig. 4 the wireless packet device log on is illustrated. When a wireless packet device first logs on **86**, an event message is sent to the MES server **88**. The MES server then broadcasts the presence of the wireless packet device to the appropriate services according to the wireless packet devices instant messaging list **90**. Also the MES retrieves information from other services regarding who is on line.

42. Figs. 5a and 5b illustrate a system and method, respectively, for replication and forwarding of user event information to the MES in accordance with a further embodiment of the present invention.

43. In Fig. 5a, wireless network **502** is connected to HLR **504** for sending user event information related to wireless devices that are connected to wireless network **502**. HLR **504** is additionally connected to Mobile Event Server (MES) **506**. HLR **504** replicates the user event information received from wireless network **502** and forwards the user event information to MES **506**. The user event information includes any network information related to the presence and/or location of a wireless device that is connected to wireless network **502**. The MES **506** receives the user event information and processes it to produce related presence and/or location information.

44. Fig. 5b shows a related method for replication and forwarding of user event information. The method includes a receiving step **552** in which HLR **504** receives user event information from wireless network **502**. The method further includes a replication and forwarding step **554** in which the HLR **504** replicates and forwards the user event information to the MES **506**. The method additionally includes a receiving and processing step **556** in which the MES **506** receives the user event information and processes it to produce associated presence and/or location information. The method includes an output step **558** in which the MES stores and outputs the resulting presence and/or location information.

45. The system and method of Figs. 5a and 5b are based on the fact that certain HLRs can be configured so that whenever the HLR receives a REGNOT, MSINACT, or CSSINACT message, for example, it will act on these specific types of messages. This

action can include replicating and forwarding the message along with associated information such as the MIN and location information to another device, such as the MES. This forwarding of information may be conducted over a variety of communication links such as SS7 or TCP/IP links, for example. Based on the forwarded information, the MES is able to determine if the associated wireless device is attached or detached from the wireless network and/or the wireless device's location. This system and method is applicable to a variety of signaling protocols such as IS-41 and GSM MAP, for example.

46. Figs. 6a and 6b illustrate a system and method, respectively, for link monitoring and forwarding of SS7 messages in accordance with a further embodiment of the present invention. Fig. 6a shows a system having an SS7 network 602, which is connected to Signal Transfer Points (STP) 604, 606 for transfer of SS7 message traffic. One STP 604 is connected to the HLRs 608 and 610 through respective sniffers 614 and 616. Likewise, the other STP 606 is connected to the HLRs 608 and 610 through respective sniffers 618 and 620. Sniffers 614, 616, 618, 620 sniff the SS7 network and allow the ability to replicate and forward either all SS7 messages or a filtered subset of SS7 messages to another devices, such as the MES 612. Furthermore, it is possible to monitor the SS7 traffic on the network directly at the STP 606 using either a monitoring port or an external link. For example, the STP manufactured by Tekelec has a built-in monitoring port, which allows monitoring of the SS7 network for various messages. These messages can either be filtered in the STP 606 or optionally in an external pre-processor 622 located between the STP 606 and the MES 612. Alternatively, the STP 606 may include some other form of external link that allows replication and forwarding of either all of the messages or a filtered subset of the messages to an external device, such as the MES 612.

47. Fig. 6b shows a related method for link monitoring and forwarding of SS7 messages. The method includes a sniffing step 652 in which the SS7 network is sniffed or monitored for SS7 messages to the appropriate HLR. The method further includes a receiving and processing step 654 in which the MES 612 receives the SS7 network messages and processes them to produce associated presence and/or location information. Additionally, the method includes an output step 656 in which the MES outputs the resulting presence and/or location information. This system and method is applicable to a variety of signaling protocols such as IS-41 and GSM MAP, for example.

48. Figs. 7a and 7b illustrate a system and method, respectively, for use of HLR triggers to forward presence and/or location information to the MES in accordance with a further embodiment of the present invention.

49. Fig. 7a shows wireless network **702** that is connected to the HLR **704** for sending user event information related to wireless devices that are connected to wireless network **702**. The HLR **704** is additionally connected to the Mobile Event Server (MES) **706** for forwarding associated presence and/or location information based on an HLR trigger condition.

50. Fig. 7b shows a related method for use of HLR triggers to forward presence and/or location information to the MES **706**. The method includes a receiving step **752** in which the HLR receives user event messages. The method further includes a processing step **754** in which the HLR **704** processes the user event messages. The processing step **754** includes parsing through SS7 messages for specific relevant fields and a determination as to whether a trigger condition **756** has been met. The trigger condition **756** can be used in an HLR **704** that is provisioned to forward wireless device presence and/or location information to a proxy server, such as MES **706**. The HLR trigger condition can include information such as whether a wireless device has been provisioned for trigger bases proxy server forwarding. If no trigger is detected, the method takes no action **758**. In the alternative, if a trigger condition is detected then the method proceeds to a forwarding step **760** in which the HLR forwards presence and/or location information. The method additionally includes a receiving step **762** in which the MES **706** receives the presence and/or location information from HLR **704**.

51. Figs. 8a and 8b illustrate a system and method, respectively, for use of MES polling of the HLR for user event information in a non-SS7 network in accordance with a further embodiment of the present invention.

52. Fig. 8a shows wireless network **802** that is connected to the HLR **804** for sending user event information related to wireless devices that are connected to wireless network **802**. HLR **804** is additionally connected to Mobile Event Server (MES) **806** via a non-SS7 link such as an EPI connection or other proprietary interface.

53. Fig. 8b shows the related method for use of MES polling of the HLR for user event

information in a non-SS7 network. The method includes a polling step **852** in which the MES **806** polls the HLR **804** database over the non SS7 link. The method additionally includes a receiving step **854** in which the response to the HLR poll is received by MES **806**. The method further includes a processing step **856** in which MES **806** processes the HLR response data in order to produce presence and/or location information. The method also includes an output step **858** in which the MES **806** outputs the resulting presence and/or location information. This system and method is applicable to a variety of signaling protocols such as IS-41 and GSM MAP, for example.

54. Figs. 9a and 9b illustrate a system and method, respectively, for use of MES polling of the HLR for user event information in an SS7 network in accordance with a further embodiment of the present invention. The system and method illustrated in Figs. 9a and 9b are analogous to the system and method described above for Figs. 8a and 8b. The only difference is that the method and system of Figs. 9a and 9b relate to SS7 links between the MES and the HLR.

55. Figs. 10a and 10b illustrate a system and method, respectively, for use of MSC generated presence and/or location SS7 messages in accordance with a further embodiment of the present invention.

56. Fig. 10a shows a system comprising an MSC **1000** connected to an SS7 network **1002** for sending SS7 messages to an HLR **1004**. Furthermore, the HLR **1004** is connected to an MES **1006**.

57. Figure 10b shows the related method for use of MSC generated presence and/or location SS7 messages. The method includes a producing step **1052** in which the MSC **1000** produces presence and/or location SS7 messages. For example, an upcoming version of GSM MAP requires support of the full C7 stack for CAMEL Application Protocol Signaling Version 3, Recommendation 3GPP 23.078. This new standard allows for presence and/or location information to be included directly in SS7 messages. The method additionally includes a sending step **1054** in which the MSC sends the presence and/or location SS7 messages to the HLR **1004**. The method additionally includes a receiving and pushing step **1056** where the HLR **1004** receives and pushes the presence and/or location SS7 messages to another device, such as the MES **1006**. The method also includes a receiving step **1058** in which the MES **1006** receives the presence and/or

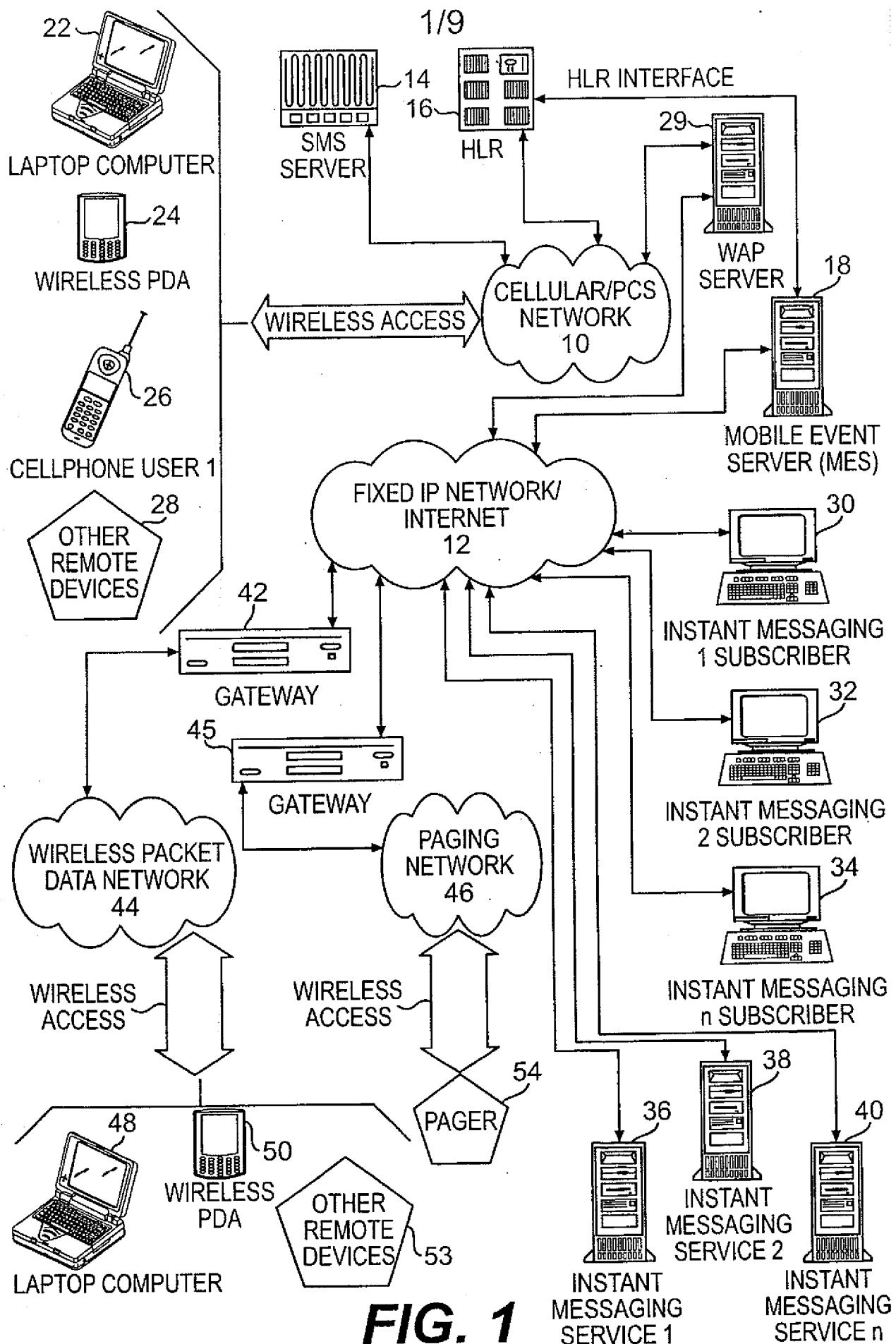
location SS7 messages and extracts the associated presence and/or location information.

58. The system and method for sharing mobile event user information between wireless networks and fixed IP networks has been illustrated. The present invention has been described in accordance with a number of preferred embodiments. However, it will be understood by those of ordinary skill in the art that various modifications and improvements may be made to the invention as described, without departing from the scope of the invention. The scope of the invention is limited only by the appended claims.

WHAT IS CLAIMED IS:

1. A method of facilitating instant messaging for a specific wireless device associated with a wireless telephone network, the method comprising:
 - receiving a signal from a home location register of the wireless telephone network indicating that the specific wireless device is connected to the wireless telephone network;
 - broadcasting, over a second network, a signal indicating presence of the specific wireless device; and
 - inquiring of one or more instant messaging providers information concerning the presence of one or more users on the second network.

2. A method of facilitating instant messaging for a specific handset associated with a wireless telephone network, the method comprising:
 - receiving a signal from a home location register of the wireless telephone network indicating that the specific handset is connected to the network;
 - broadcasting, over a fixed network, a signal indicating presence of the specific handset;
 - inquiring of one or more instant messaging providers information concerning the presence of one or more users on the fixed network;
 - transmitting to a short messaging service platform any information received from the one or more instant messaging providers information concerning the presence of one or more users on the fixed network, along with information directing the short messaging service to forward the transmitted information to the specific handset.



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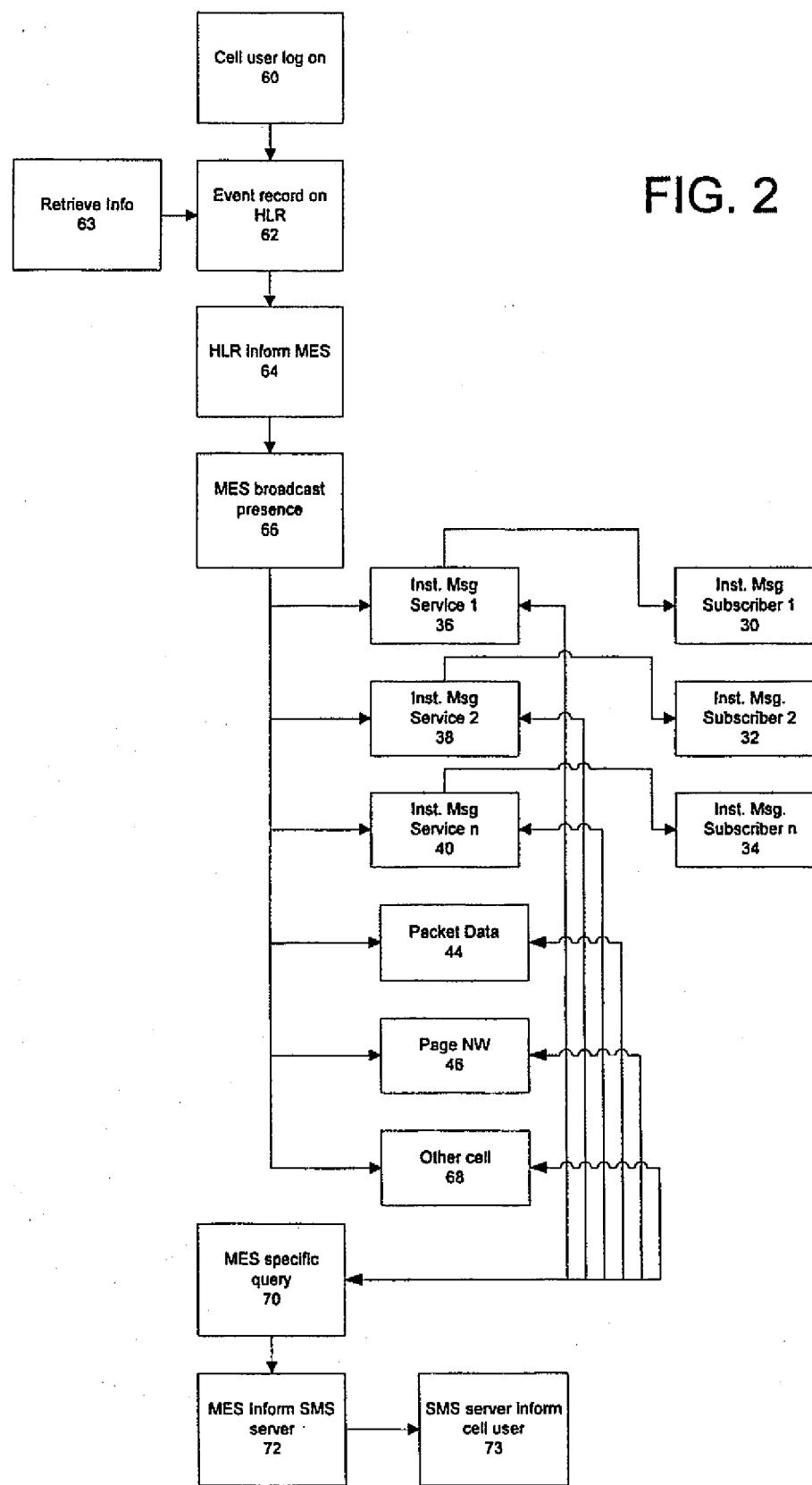


FIG. 3

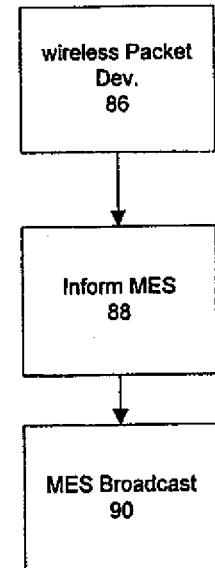
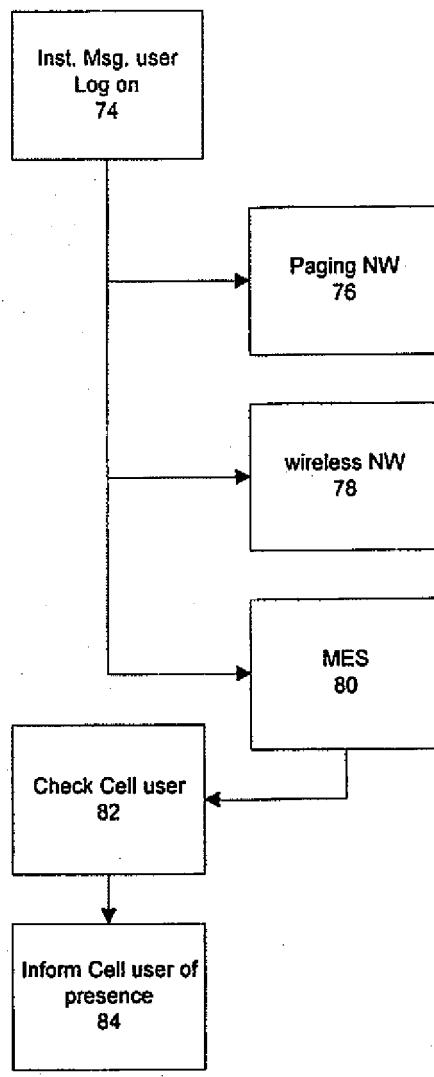


FIG. 4

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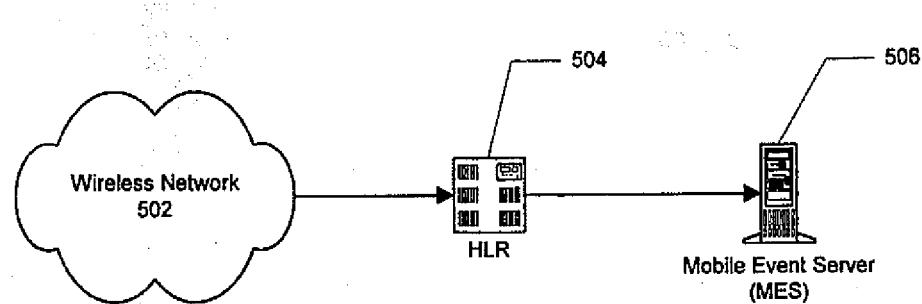


FIG. 5A

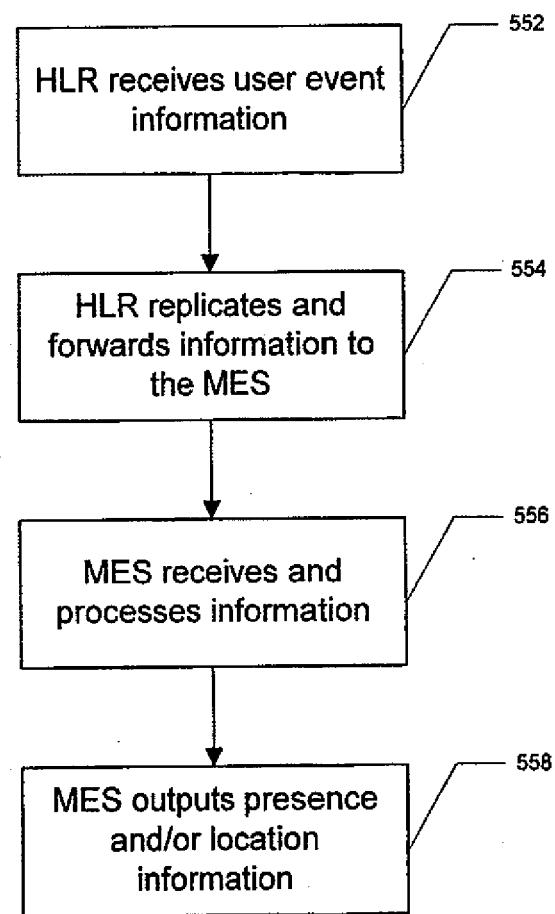


FIG. 5B

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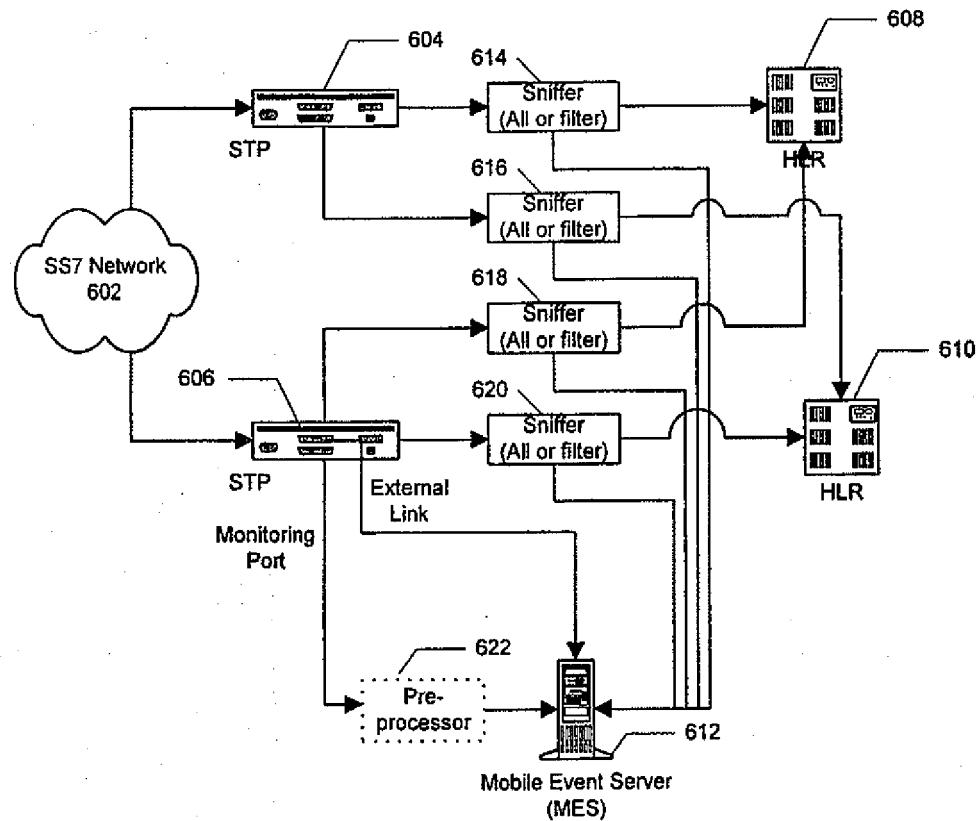


FIG. 6A

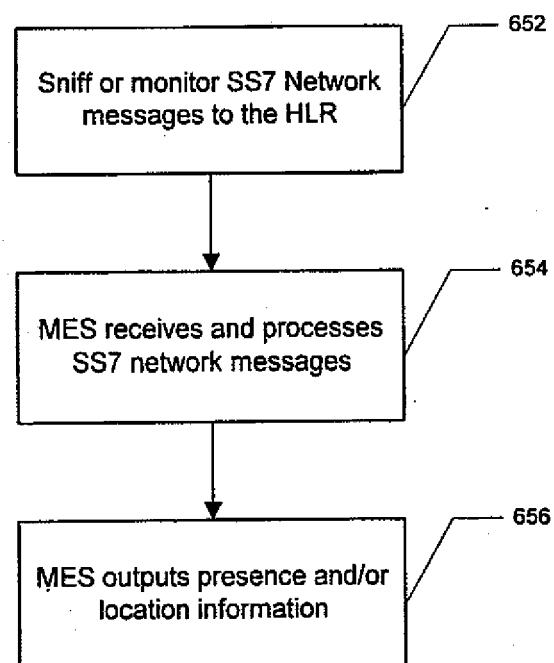


FIG. 6B

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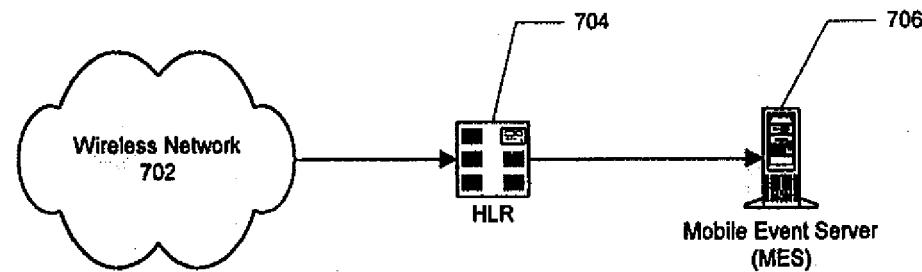


FIG. 7A

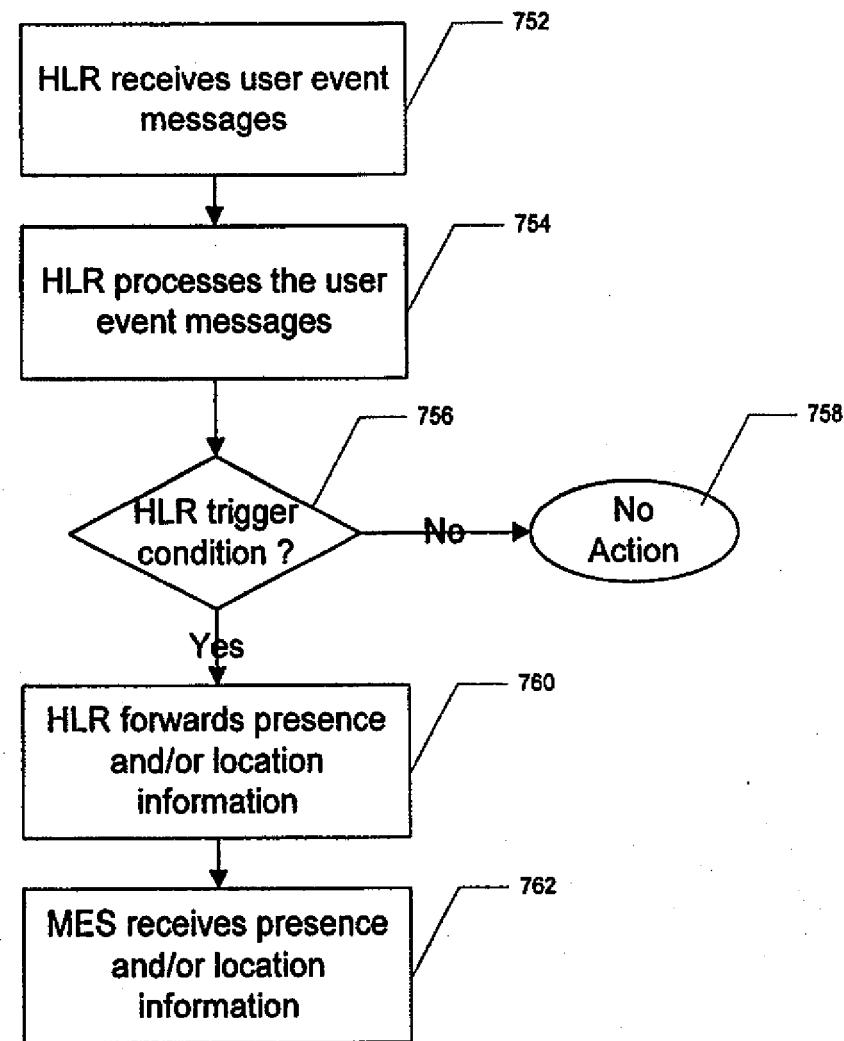


FIG. 7B

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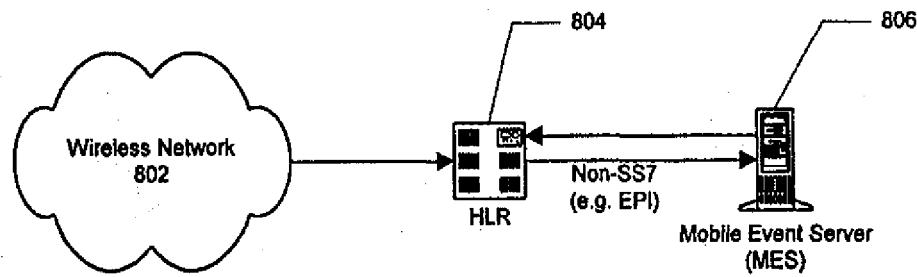


FIG. 8A

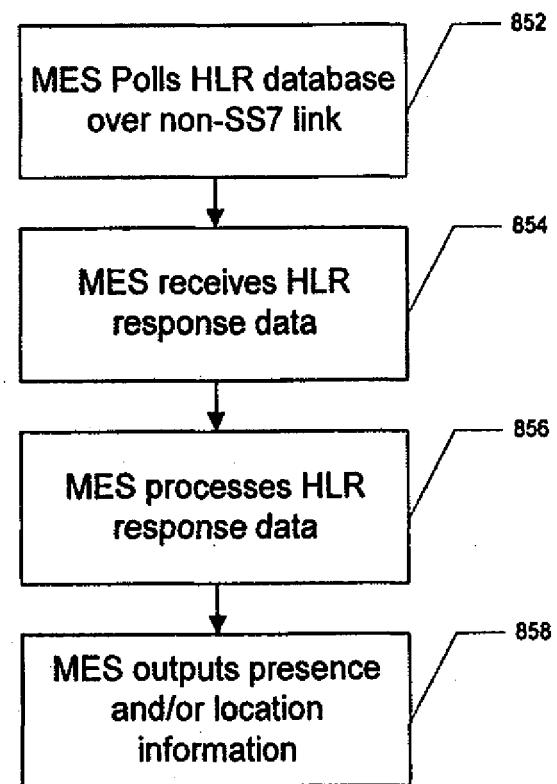


FIG. 8B

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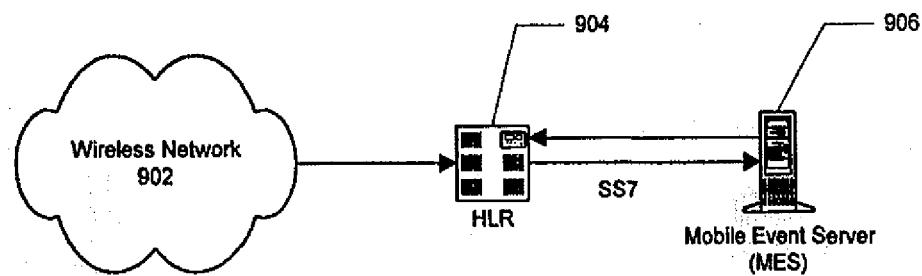


FIG. 9A

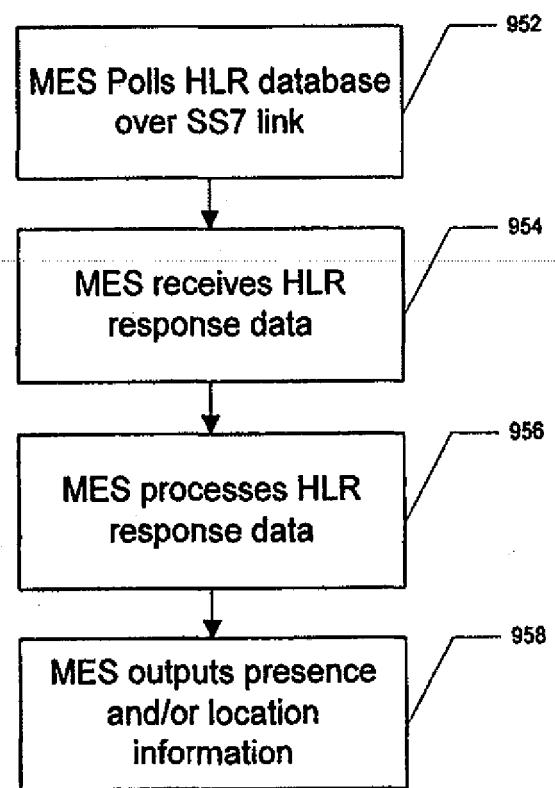


FIG. 9B

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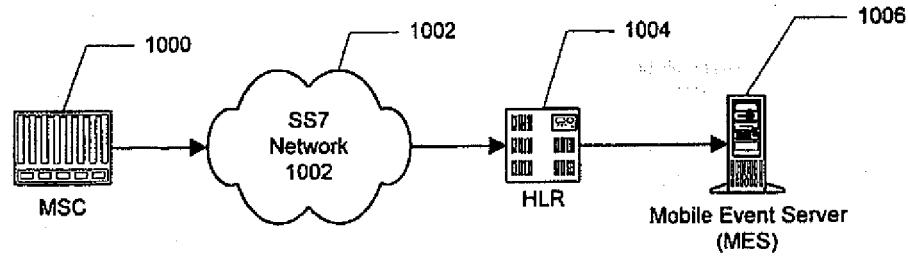


FIG. 10A

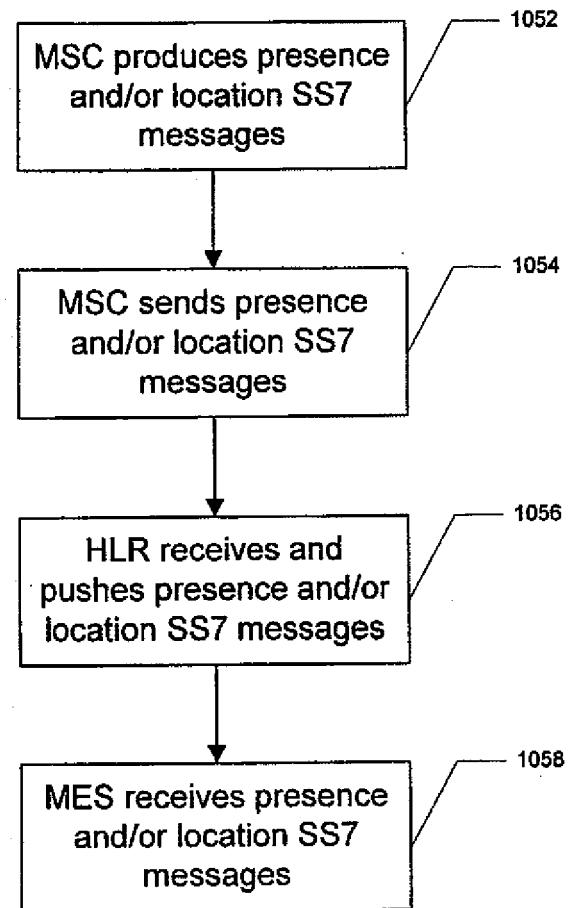


FIG. 10B

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
2 August 2001 (02.08.2001)(10) International Publication Number
WO 01/56308 A3

(51) International Patent Classification⁷: H04Q 7/22, H04L 29/06

(21) International Application Number: PCT/US01/02526

(22) International Filing Date: 26 January 2001 (26.01.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data: 60/178,142 26 January 2000 (26.01.2000) US

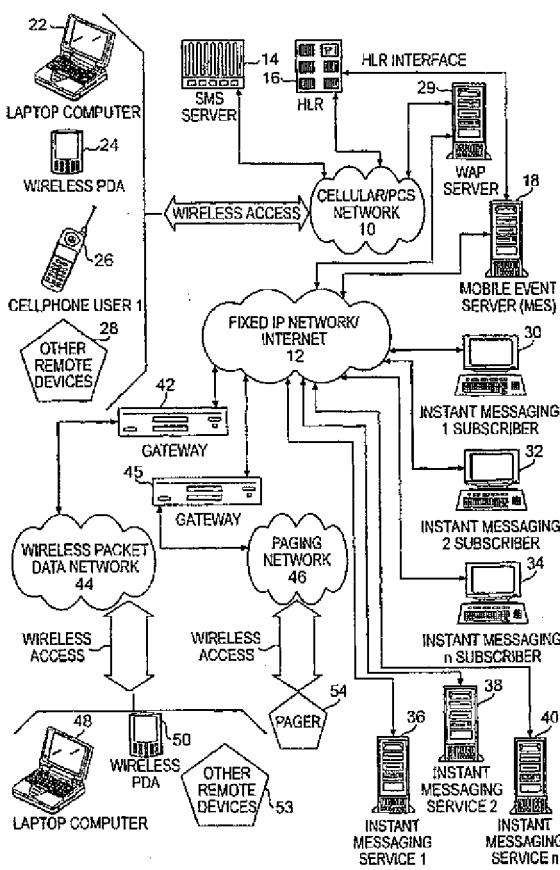
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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,

(Continued on next page)

(54) Title: METHOD AND APPARATUS FOR SHARING MOBILE USER EVENT INFORMATION BETWEEN WIRELESS NETWORKS AND FIXED IP NETWORKS



(57) Abstract: The present invention provides for a system and method for sharing user event information (such as, and without limitation, presence on a network) among mobile (wireless) devices and those connected to fixed IP networks such as the Internet. In accordance with embodiments of the invention, the system and method support instant messaging between wireless devices and fixed IP network devices and between wireless devices and other wireless devices. The term wireless device is used broadly to include cell phones, laptop computers with wireless modems, wireless PDAs, and any other remote wireless devices.

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IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

(88) Date of publication of the international search report:
3 January 2002

Published:

— with international search report

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INTERNATIONAL SEARCH REPORT

Intern: Application No:

PCT/US 01/02526

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 H04Q7/22 H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category ^a	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99 34628 A (ERICSSON TELEFON AB L M) 8 July 1999 (1999-07-08) page 2, line 18 -page 3, line 16 page 6, line 15 -page 7, line 29 page 8, line 18 -page 9, line 14 page 11, line 25 - line 29 abstract; figure 2B	1,2
X	WO 97 13382 A (NORTHERN TELECOM LTD) 10 April 1997 (1997-04-10) page 2, line 21 -page 5, line 2	1,2 -/-

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Date of the actual completion of the international search

5 September 2001

Date of mailing of the international search report

12/09/2001

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ESCHENBURG A: "WO LAUFEN SIE DENN? ICQ HAELT VERBINDUNG ZU BEKANNTEN" CT MAGAZIN FUER COMPUTER TECHNIK, DE, VERLAG HEINZ HEISE GMBH., HANNOVER, no. 22, 26 October 1998 (1998-10-26), pages 92-95, XP000779803 ISSN: 0724-8679 the whole document	1,2
P, X	EP 1 071 295 A (PHONE COM INC) 24 January 2001 (2001-01-24) paragraph '0006! - paragraph '0013! paragraph '0022! - paragraph '0029! paragraph '0033! - paragraph '0034! abstract; figure 5B	1,2